Atlantic Council
BRENT SCOWCROFT CENTER
ON INTERNATIONAL SECURITY

ISSUE BRIEF

Left of Launch: Countering Theater Ballistic Missiles

JULY 2017 HERBERT C. KEMP

NATO currently finds itself in an increasingly competitive international environment, with potential adversaries who field, among other things, progressively capable ballistic and cruise missile capabilities. This is particularly the case with Russia, which has proven itself capable of fielding conventional long-range strike capabilities that can reach far into NATO territory. Russia's ballistic missiles, such as the Iskander system, are also a key part of its growing anti-access/area-denial networks. In the Kaliningrad enclave, for example, the deployment of Iskander missiles represents a real threat not only to NATO members in the region, but also to potential forward basing locations needed for US and NATO reinforcements in a crisis, as well as deployed US and allied forces in the field.

This issue brief takes a broad, non-NATO approach to the growing challenge of ballistic missiles for the United States and its allies and considers new technologies and methods to meet the threat. While the approach is global, many of the considerations and recommendations in this issue brief are of relevance to the Alliance and its members as NATO pursues options on how to provide credible collective defense and deterrence in a newly insecure Europe.

Introduction

Ever since the scud missile attacks against Saudi Arabia and Israel during the Gulf War in 1991, efforts have been underway in earnest to develop and field missile defense capabilities that would protect both military forces and high-value civilian targets from the threat posed by theater ballistic missiles (TBM). While the threat of ballistic missiles has been part of the strategic landscape since the advent of intercontinental ballistic missiles (ICBMs) during the Cold War, ICBMs have remained a deterrent threat for use only in extremis, while conventionally armed TBMs have been employed in actual conflicts, have grown in numbers, capability and sophistication, and potentially threaten US and allied conventional war-fighting capabilities in various theaters of concern. It is conceivable that the ability of TBMs to overcome ballistic missile defenses with saturation raids and countermeasures may be approaching the point at which terminal missile defenses alone, while essential, will no longer be sufficient.

The Brent Scowcroft Center's **Transatlantic Security Initiative** brings together top policymakers, government and military officials, business leaders, and experts from Europe and North America to share insights, strengthen cooperation, and develop common approaches to key transatlantic security challenges. This issue brief continues the Transatlantic Security Initiative's focus on collective defense and deterrence in Europe.

It is time to change the game from a purely defensive battle to one in which the fight is taken to the source—to attack the TBM launch systems and their supporting infrastructures before missiles can be launched. The launch of a TBM is simply the last link in a complex chain of events required to deliver a kinetic effect. All parts of the chain leading up to the launch event are potentially vulnerable to disruption or destruction, and the time is right to undertake a serious effort to engage the TBM threat "left of launch."

Background

During the Gulf War in 1991, Iraq fired some eighty-eight modified SSC-1 scud missiles (al-Husayn and al-Abbas types) against Israel and Saudi Arabia. Despite intense efforts to find and destroy the scud missile transport erector launchers (TELs), success rates were minimal. Allied forces flew some 2,400 sorties over suspected launch sites in western Iraq to identify the launch sites based on the launch plume in order to destroy the TEL before it could escape. Of the eighty-eight scud missiles launched, forty-two launches were observed by Coalition forces; however, in only eight cases were Coalition aircraft able to get within range to release weapons and there were no confirmed kills of scud TELs.[1] Special operations forces (SOF) were only marginally more successful, encountering significant difficulties in concealing their own locations as well as difficulties in coordinating air strikes when targets were available. Some eventually resorted to attacking the TELs directly with shoulder-fired, anti-tank missiles before the SOF units were eventually extracted.[2]

Following the Gulf War, development of missile defenses capable of intercepting and destroying TBMs progressed, with the continued fielding of increasingly more capable missile interceptors. Allied nations have developed other highly capable systems as well, with some able to intercept both tactical ballistic missiles and cruise missiles.[3] Deputy Defense Secretary Robert O. Work has advocated for additional investment in the development of short-range terminal defenses, including such systems as rail guns and powder guns with "smart projectiles."[4]

A number of options for Boost Phase Intercept (BPI) of TBMs were envisioned and some achieved various stages of development, resulting in such concepts as the Airborne Laser platform or employing long dwell unmanned aerial vehicles (UAV) over potential TBM launch areas, ready to engage TBMs in boost phase with high speed air-to-air missiles. Other BPI concepts from the Strategic Defense Initiative included such systems as the Kinetic Energy Interceptor, which would have provided land-based and sea-based options, and Brilliant Pebbles, a proposed space-based system.[5] None of these systems were fielded.

> "It is time to change the game from a purely defensive battle to one in which the fight is taken to the source. . ."

As the United States and its allies have been researching and developing new capabilities, potential adversaries have been learning as well. First, they realized that fixed launchers were vulnerable, while mobile launchers were difficult to find and therefore were more likely to survive. Second, they learned that small numbers of non-maneuvering ballistic missiles could be effectively engaged by then-current and developing Western missile defense systems. Third, they recognized that allowing US and allied air forces to dominate the air conceded critical advantages to the West in terms of their ability to sense the battle space and engage targets within that space. Fourth, they became aware of both the capabilities and the potential vulnerabilities of the highly networked systems used to employ kinetic and non-kinetic effects.

1 A. Vick, R. Moore, B. Pirnie, and J. Stillion, *Aerospace Operations Against Elusive Ground Targets* (Santa Monica, CA: RAND, 2001), Chapter 3, https://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1408/MR1408.ch3.pdf.

2 Ibid.

3 Aster SAMP/T Surface-to-Air Missile System, Army-Technology.com, December 10, 2015, http://www.army-technology.com/projects/aster-30/.

4 Bill Sweetman, "Pentagon Leaders Turn Up Heat on Advanced Weapons," Aviation Week & Space Technology, August 6, 2015, http://aviationweek.com/defense/pentagon-leaders-turn-heat-advanced-weapons.

5 Missile Threat, Center for Strategic and International Studies (CSIS) Missile Defense Project, last accessed June 9, 2017, http://missilethreat.com/defense-systems.

Russian Iskander-M system missiles on a 9T250-1 Transport Loader, May 2015. *Photo credit*: Boevaya Mashina/Wikimedia.

The result of the foregoing lessons learned by our potential adversaries has been the evolution of an asymmetric offensive capability based on increasingly sophisticated theater ballistic and cruise missiles operating under the umbrella of increasingly sophisticated and lethal surface-to-air missile defenses. At least one writer has even posed the question of whether a "revolution in military affairs" had been achieved by the proliferation of highly capable, mobile theater missile systems. Noting that potential adversaries had been investing in making their theater missile systems survivable, it was observed that over the past two decades, theater missiles evolved from threats involving small numbers of missiles launching from fixed locations against area targets to complex multiple launches from mobile systems fired against point targets with precision.[6]

6 W.F. Bell, "Have adversary missiles become a revolution in military affairs?" *Air & Space Military Journal, 28(5),* 2014, 45-70, http://search.proquest.com/docview/1610986505?accountid+8289.

Sensing the Battle Space

Since 1991, the US capability to sense and understand the battle space has expanded significantly due to the introduction of several key concepts and enabling technologies. Airborne reconnaissance platforms have rapidly expanded in number and capability, particularly with the introduction of remotely piloted aircraft (RPA), which in recent conflicts have provided the capability for persistent surveillance of high-interest targets using full motion video (FMV). Persistent FMV has operated within the broader umbrella of electro-optical (EO), infrared (IR), multispectral imaging (MSI), and synthetic aperture radar (SAR) imaging provided by high-altitude platforms. [7] Moreover, electronic intelligence collected by a number of platforms can be used to cue imaging sensors, provide warning, and add context to imagery intelligence. The integration

7 For example of systems see, see RQ-4 Global Hawk, Northrop Grumman, http://www.northropgrumman.com/capabilities/rq-4block20globalhawk/documents/hale_factsheet.pdf; and U-2 High Altitude Reconnaissance Aircraft, AirForceTechnology.com, http://www.airforce-technology.com/projects/u2/.

of intelligence gathered through national space-based assets and airborne tactical systems further leverages all the collection mediums available to the United States and allied nations. The use of global positioning system (GPS) data and geo-spatial foundation data support precise location and targeting of hostile forces and installations. Powerful analytical tools and big data analytics have significantly advanced our ability to analyze and understand the data we collect.

The current global intelligence, surveillance, and reconnaissance (ISR) enterprise is enabled through the concept of distributed operations that has grown in earnest since the late 1990s. Whereas exploitation of intelligence data was often limited to onboard exploitation in the collector aircraft or post-mission exploitation on the ground, the current system of systems permits near real-time processing and exploitation of intelligence data throughout the enterprise. The current distributed common ground system (DCGS) architecture instantiated across the services is one such example.[8] Consisting of a network of ground stations on a worldwide network, the DCGS can accept sensor feeds from airborne platforms in a given theater and exploit that data in near real time at any one of a number of ground stations across the enterprise or, if needed, shift the exploitation mission from one ground station to the next. Distributed operations are enabled through the high-speed wide area networks supporting these ground stations and the multiple satellite data links connecting airborne reconnaissance platforms to the networked ground stations.

Despite this success, the ISR enterprise has limitations in the context of supporting the detection and engagement of mobile TBMs in a contested environment. Many of the current reconnaissance platforms in the US inventory may not be survivable in a contested environment and would likely only be able to collect from stand-off distances that keep them out of the range of the defensive missile umbrella and hostile air threat. Further, it must be assumed that network disruption is both possible and probable in a large force-on-force engagement with a peer or near-peer competitor. Certainly, there is also significant potential for disruption or denial of satellite-based data links and GPS signals. New capabilities will be needed to detect and engage mobile targets operating in contested environments.

8 "Distributed Common Ground Systems," GlobalSecurity.org, Intelligence, 2011, http://www.globalsecurity.org/intell/systems/dcgs.htm.

Understanding the Target System

Discussions of countering mobile missiles most often focus on detecting and attacking the mobile launcher before it can launch a missile, and indeed this is a logical starting point for the discussion. However, a mobile TBM must be understood and approached as one element in a complex system of systems; all elements of that system of systems should be considered as candidates for destruction, disruption, or suppression as part of a counter-TBM campaign.

A mobile TBM fire unit is part of a larger (typically brigade-sized) unit with multiple transporter erector launchers, additional missiles and loaders, support vehicles, communications vehicles, maintenance vehicles, and other equipment. TBM units require both organic command and control systems and links into the larger theater command control systems of the supported force. TELs are expected to deploy to individual "hide sites," where they would minimize physical and electronic signatures until directed to emerge from hiding, fire their missiles, and quickly move away from the launch site.

When viewed as a system of systems, all the various physical and electronic components represent potential targets, whether moving or at rest. Within the "life cycle" of a mobile missile system engagement, a brigade would deploy from permanent garrison to a forward assembly area(s). TELs would beb deployed to forward hide sites to await launch orders. While in hide sites, as noted in one study, "TBMs are difficult to locate and need not emit any exploitable signals prior to launch."[9] It is possible, but unlikely, that a TEL would be collocated with its loader. More likely, loaders would be dispersed for survivability. However, once highlighted by the launch of its missiles, the TEL would likely reposition to the loader for missile resupply at which point the TEL, the loader, or potentially both would be in motion and, thus, detectable.

Throughout the life cycle of the TBM unit's operations, each movement, each launch, each support activity, each use of the command and control system creates signatures that are potentially detectable by various

9 M. Corbett, "The Role of Airpower in Active Missile Defense," *Air and Space Power Journal*, 59, 2010.

sensors designed to exploit the variety of phenomena their actions and presence create. Such signatures may be either individually or collectively able to identify and locate the TBM unit or its components, which can then be targeted by various means. The challenge, of course, is to posture the ISR enterprise to collect, analyze, and disseminate the targeting data required and to do so in the midst of a theater level conflict in which TBMs are only one target set of many.

A Concept of Operations for Left of Launch

Counter-offensive operations have always been part of US military doctrine, and the need to go "left of launch" fits well within those doctrinal constructs. Moreover, it is highly unlikely that counter-offensive operations against TBMs would occur in isolation. These operations would more likely take place within the context of offensive operations as part of a larger theater-level air campaign. However, in order to operationalize "left of launch" as a subset of offensive air operations, an operational architecture for countering mobile TBMs must be developed—an architecture that can detect and track mobile TBMs and their supporting elements, deliver targeting information to attack systems, and put weapons on target. Moreover, all of this must be done in the face of highly lethal air defenses and very intense communications jamming.

Intelligence preparation of the battle space (IPB) is an essential prerequisite to structuring and employing the ISR enterprise to detect and support kinetic targeting of the critical elements of the TBM threat. Thorough IPB will help to delimit the areas of the battle space in which to focus the TBM search. An IPB-based approach would factor threat TBM capabilities, doctrine, plus terrain and other environmental limitations to define the limits of the search area. Such an approach requires continuous collection, analysis, and close monitoring of threat TBM systems in pre-conflict stages.

Multiple sensor layers are applicable at different stages of the search, but would be employed in a transition from broad area search to detailed target identification and location. Although a detailed discussion of specific sensor capabilities is beyond the scope of this issue brief, an operational architecture might include the following elements:

- Big data, consisting of large volumes of inferential data from both classified and unclassified sources, would serve to further delimit the areas in which to cue airborne and space-based sensors.
- Space-based sensors that can be cued to sense specific locations and signatures based on the IPB and analysis of the inferential data.
- Airborne sensors on survivable platforms must be employed to provide for persistent surveillance within the battle space.
- Attack platforms must have onboard sensors for target acquisition, must be able to operate with high levels of autonomy, and must be survivable in the future battle space.

Big Data Analytics

"Big data are high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation."[10] Within the context of locating mobile missiles, big data analytics provide a means of exploiting large amounts of data from multiple sources, including data from classified sources as well as open source data. For much of the data collected, any individual data point may not be uniquely associated with the mobile TBM. However, the same data taken in the aggregate may inform us of the probability of a TBM unit being at a given location. Big data, combined with IPB techniques and overlaid on precise geo-spatial foundation data, has the potential to present relatively precise location data for TBM units and their components.

Space-Based Sensors

The space-based layer of the architecture provides both reconnaissance capabilities as well as missile launch warning. High-resolution imaging satellites are typically in low earth orbit (LEO) for best resolution. Electro-optical (EO) satellites are typically placed into sun-synchronous orbits for best coverage. An EO satellite in low earth orbit will only have access to a given spot on the earth for a few minutes in a given pass, with revisit times over a given point varying depending on the orbit chosen. However, the ability to image a particular point on the earth may be improved by the swath width of the imaging sensor and its ability to image

10 Gartner IT Glossary, available via http://www.gartner.com/it-glossary/big-data.

The Aegis Ashore Missile Defense Complex in Deveselu, Romania, the first land-based defensive missile launcher in Europe as part of the NATO defensive shield, May 2016. *Photo credit*: US Naval Forces Europe-Africa/Flickr.

off-track. Synthetic aperture radar (SAR) satellites also operate in LEO when high resolution is required and are subject to the same coverage and revisit limitations. The principal difference is that the SAR sensor permits imaging through weather and at night and, as such, is complimentary to the EO satellite.[11] High-resolution imaging satellites in LEO, then, may collectively offer frequent revisit times, but may not provide persistent surveillance of mobile forces. However, with the advent of multiple commercial satellite services, particularly with large constellations of multiple smaller satellites, known as SmallSATs, this capability is rapidly evolving. Commercial SAR satellites offer resolution in the one meter range, sufficient for recognition of objects such as tanks, but not sufficient to identify specific type (which would require submeter resolution).[12] The US Air Force is evolving a concept of sensing as a service, with reliance on commercial satellite systems, which it believes could hold camouflaged and mobile targets at risk. By 2018, such SmallSAT constellations with EO, IR, MSI, HSI, and radar capabilities may be able to offer images with resolution of 0.5 to 5 meters and coverage gaps on the order of 1 to 10 minutes.[13]

The space-based infrared systems (SBIRSs) constellation will be able to provide ". . . missile early warning, missile defense, battlespace awareness. . ."[14]

11 D. Pegher, D and J. Parish, "Optimizing Coverage and Revisit Times in Sparse Military Satellite Constellations: A Comparison of Traditional Approaches and Genetic Algorithms," (Master's Thesis, Naval Post-Graduate School, September 2004), www.dtic.mil/dtic/tr/fulltext/u2/s427260.pdf.

12 J. Herrman, (n.d.), Introduction to SAR Applications, Commercial Satellite Working Group, US Geospatial-Intelligence Foundation, Retrieved on December 27, 2015, usgif.org/system/uploads/2545/original/Overview_SAR_Basic.pdf.

13 Commercial Space-Based GEOINT, DCS/Intelligence, Surveillance and Reconnaissance, May 2015, HQ USAF, www.defenseinnovationmarketplace.mil/resources/Commercial_GEOINT_Vision.pdf.

14 Space Based Infrared Systems Fact Sheet, Air Force Space Command, August 13, 2015, http://www.afspc.af.mil/library/factsheets/factsheet.asp?id=3675.

Hence, SBIRS launch detections will quickly identify TBM launch areas in which the ISR resources must be focused to support counter offensive operations.

Airborne Sensors

Big data analytics and space-based sensors will be able to delimit TBM operating areas, and (in the case of SBIRS) provide post-launch locational data. Over time, SmallSAT networks may be able to locate and support the targeting of mobile TBMs; in the near term, employment of persistent surveillance capability in the battle space will likely be required. In approaching air operations in a contested environment, the Air Force envisions employment of a mix of airborne platforms, divided into those that must operate outside of the reach of enemy air defenses and those that have the survivability characteristics needed to operate within the reach of those air defenses. One potential vision is the use of a low observable, multi-role remotely piloted aircraft (RPA) to provide persistent surveillance within the enemy air defenses.[15] All data links would need to be jam-resistant. In the near term, such a platform would require access to a low probability of intercept/low probability of detection (LPI/LPD) data link. This would probably require data exfiltration back to a DCGS ground station for inject into a command and control node outside the battle space and subsequent relay to a shooter platform inbound to the battle space. A future capability to consider would be the proposed "combat cloud." The combat cloud is an evolving concept and is analogous to cloud computing, but in this context, "...a combat cloud will capitalize on the ubiquitous and seamless sharing of information among multi-domain weapon systems to rapidly exchange data between sensors and shooters to act as a cohesive whole."[16]

A low observable RPA would necessarily employ passive sensors and would require cueing from off-board sensors and sources. Employment of FMV would be desirable, but the bandwidth required might not be compatible with the limitations imposed by the use of LPI/LPD waveforms. Even without FMV, however, an RPA would be able to maintain persistent surveillance of a TBM operating area through frequent imaging; multi-spectral imaging (MSI) sensors would offer advantages over traditional EO sensors, especially when used to detect hidden and camouflaged targets.[17]

Attack Platforms and Weapons

The constraints imposed by the expected contested environment shapes the potential solution space for attack platforms and weapons. As previously noted, the potential for GPS degradation, communications jamming, and highly lethal defenses must be accounted for in any solution to countering mobile TBMs. Since our current battle management is reliant on robust communications with heavy use of reach back elements, communications from the battle management system into the battle space cannot be assured.[18] In the near term, this set of constraints suggest that the attack platform must be survivable in the air defense environment, must have high levels of autonomy, and must be equipped with accurate weapons that have launch and leave features and reduced reliance on GPS-based data. The requirement for autonomy rules out unmanned platforms, in the near to mid-term at least, suggesting that the near-term platform requirement would best be supported by a fifth-generation fighter armed with weapons capable of attacking both stationary and mobile targets based on terminal guidance with internal sensors.[19] Stand-off cluster munitions may also be suitable if permitted under the rules of engagement.

Future systems are either in development or have been discussed by other researchers. Swarming RPAs and hypersonic platforms, operating as part of a distributed system, have been suggested as one potential capability to locate and attack mobile systems.[20] Loitering, autonomous, or semi-autonomous armed RPAs have also been suggested.[21] Clearly, a large platform such

15 Lt. Gen. B. Otto, USAF, AF ISR: Lessons Learned to Build the Future, Presentation to the Mitchell Institute of Aerospace Studies, June 9, 2016.

16 Lt. Gen. D. Deptula, USAF, Ret., "The Combat Cloud: A Vision of 21st Century Warfare," The Mitchell Institute of Airpower Studies, 2015.

17 J. Keller, "Raytheon Wins Another Contract for Multi-Spectral Targeting Systems for Navy Helicopters," *Military & Aerospace Electronics,* March 24, 2014, http://www.militaryaerospace.com/articles/2014/03/raytheon-multispectral-sensor.html.

18 L. Gossett, "Innovation in the AFRL Enterprise," (presentation, Air Force Research Laboratory, August 27, 2014, Wright-Patterson AFB, OH).

19 GBU-53/B SDB II Fact Sheet, 2010, http://www.airforcemag.com/SiteCollectionDocuments/Reports/2010/August%202010/Day25/SDBII_factsheet_0810.pdf.

20 H. Foster, "The Joint Stealth Task Force: An Operational Concept for Air-Sea Battle," January 1, 2014, *Joint Force Quarterly*, 72, National Defense University Press, http://ndupress.ndu.edu/Media/News/NewsArticleView/tabid/7849/Article/577481/jfq-72-the-joint-stealth-task-force-an-operational-concept-for-air-sea-battle.aspx.

21 R. Haddick, Stopping Mobile Missiles: Top Picks for Offset Strat-

as a long-range bomber armed with a large number of terminally guided weapons and enabled through the combat cloud would offer significant advantages in terms of both TBM destruction and, potentially, TBM suppression.

Conclusions

Unless a decision is made to preemptively attack the potential threat TBMs, one must assume that at least some TBMs will be launched against US and allied forces in the initial stages of conflict, in which case the Allied Integrated Air and Missile Defense system will defend against the initial attacks. With that as a given, the objective of counter-offensive operations should be to erode and suppress follow-on launches from the enemy mobile TBM force in order to reduce or eliminate pressure on our own air and missile defenses.

Developing an effective counter-offensive campaign capability and strategy against theater ballistic missiles should be an essential part of our broader strategy to defend military and civilian targets against ballistic missile attack. This requires engagement of all elements of the mobile missile system, not just the TELs, and further requires engagement of mobile missile threats at every part of their operational cycle, from movement to launch sites through terminal defense of high-value assets. Continued development of future systems will be essential to delivering future capability. However, the mobile TBM threat exists today and can be addressed with capabilities that are available today. With the right architecture and concept of operations, it is possible to deliver a functional capability in the near term, which would set the foundation for developing enhanced capabilities in the future.

Herbert C. Kemp is a retired Air Force colonel with more than forty years of military and industry experience in ISR. He is currently the president and CEO of OneALPHA Corporation and is a published author and adjunct faculty member.

egy, *Breaking Defense*, January 23, 2015, http://breakingdefense.com/2015/01/stopping-mobile-missiles-top-picks-for-offset-strategy/.

Atlantic Council Board of Directors

Atlantic Council

The Atlantic Council is a nonpartisan organization that promotes constructive US leadership and engagement in international affairs based on the central role of the Atlantic community in meeting today's global challenges.

Atlantic Council

1030 15th Street, NW, 12th Floor,
Washington, DC 20005

(202) 463-7226, www.AtlanticCouncil.org